10/500902

PCT U03/00019

10 Rec'd PCT/PTO 06 JUL 2004

REC'D 04 FEB 2003

WIPO PCT

AUSTRALIA

Patent Office
Canberra

I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PR 9898 for a patent by LAKE TECHNOLOGY LIMITED as filed on 09 January 2002.

WITNESS my hand this
Twenty-fourth day of January 2003

J. Billingsley

JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

MMONWEALTH OF AUSTRALIA
AUSTRALIA
PATENT OFFICE

CERTIFIED COPY OF
PRIORITY DOCUMENT

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

P/00/009
Regulation 3.2

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title: Interactive spatialized audiovisual system

The invention is described in the following statement:

Interactive Spatialized Audiovisual System

Field of the invention

The present invention relates to an interactive spatialized audiovisual system for conducting chat room type conversations in a three dimensional audio environment.

Background of the invention

Recently, chat rooms have become a very popular forum for intercommunication over the Internet. Normally, these chat rooms involve users typing in information using a computer type device interconnected to a computer network such as the Internet.

The use of chat rooms allows for an increase level of personal intercommunication and on-line discussion. Normally, the chat room may be discussion topic based.

Conventional chat programs provide a text input-based chat environment. People can either choose to chat with an individual, or within a group. A messaging service is also provided to enable short messages of limited length to be sent between two parties. This online program has proved itself to be very popular over time and has gained many users.

Unfortunately, the chat room scenario has a number of drawbacks. These include the need to type information on a keyboard type device for entering to the chat room. Typing is often a laborious and non-spontaneous process when compared merely to the process of talking. Further, chat room conversations can often become confusingly intermixed.

Summary of the invention

According to a first aspect of the invention there is provided an interactive spatialized audiovisual system typically in the form of a computer network facility for linking a plurality of remote user terminals, the facility comprising:

- a user database including user status information;

- receiving means for receiving at the computer network a plurality of audio streams and associated locating data from the remote user terminals for virtually locating the users relative to one another within a virtual environment;

- selection means for selecting at least a first group of the audio streams in a first selection process based on status information in the user database;

- transmitting means for transmitting the selected group of audio streams and associated locating data to a first selected user terminal for spatialization of the selected group of audio streams relative to a first listener-based audio reference frame which is substantially coherent with the visual representations of the audio sources at the first user terminal defined by the locating data.

Preferably, the system includes merging means for merging at least some of the audio streams into a merged audio stream for transmittal to the user terminal, and spatializing means for spatializing the merged stream so as to provide for a background audio effect in the audio reference frame at the user terminal.

Conveniently, the selection means are arranged to select different groups of audio streams according to different selection processes based on the user status information in the user database, for transmission to the corresponding user terminals.

The user status information typically includes user location data for locating the user in the virtual environment, user orientation data for orientating the user both with respect to the other users and to the virtual environment, user listening status information and user talk status information.

The user listening status information is arranged to allow the user to listen to other selected users or groups in the environment.

The user listener status may be based on at least one of the following:

- the selection of M closest audio sources from N audio sources;

- the selection of M loudest sources based on the amplitude of the source signal and/or the distance of the source from the listener;

- a user-driven selection process determined by the subject user or other users;

- a moderator-driven selection process in which a "moderator" in the environment is able to control the talk and listen status of the other users;

- the geography or topology of the virtual environment, in which barriers and openings such as walls and doorways are arranged realistically to affect the listening capability of a particular user.

-the creation of temporary "soundproof" barriers around user groups.

The barriers may define one or more chat rooms, with at least some of the audio streams in a particular room being summed or merged and spatialized to achieve a background reverberation effect characteristic of that particular room.

The audio streams in adjoining rooms or areas may also be merged and spatialized to create "threshold" effects at entrance/exit points.

"Dry" and "wet" room signals may be respectively be generated using summed non-reverberated audio sources and audio sources which have been summed and reverberated.

In general terms, the invention seeks to provide a virtual environment in which there is a measure of coherence between the visible and audible effects within the virtual environment.

Typically, the user database utilizes a plurality of different selection criteria based on the status of the particular user to whom the selected audio streams and associated locating information is being transmitted.

The invention extends to a method of providing an interactive spatialized audio facility comprising the steps of:

- receiving from a plurality of user-based audio sources a plurality of corresponding audio streams and associated locating data capable of virtually locating the audio sources relative to one another within a virtual environment;

- reading user status data;

- selecting at least some of the audio streams based on the user status data;

- transmitting the selected audio streams and associated locating data to a first listener destination for enabling the display of visual representations of the virtual locations of at least some of the selected audio sources within the virtual environment, and

- spatializing the selected audio streams relative to a first listener-based audio reference frame which is substantially coherent with the visual representations of the audio sources.

Preferably, the method includes the steps of:

- enabling the user status data to be altered,

- reading the altered user status data, and

- selecting at least one of the audio streams based on the altered user status data,

- wherein at least one of the audio streams selected using the altered user status data is different to the prior selected streams.

Conveniently, the method includes the steps of:

- merging at least some of the audio streams,

- transmitting the merged audio streams to the first listener destination, and

- spatializing at the first listener destination the merged audio streams so as to provide a background audio effect within the virtual environment.

In accordance with a further aspect of the present invention, there is provided a system for providing for spatialized conversation over a network environment, the system comprising:

- at least one user terminal;

- a computer network capable of streaming audio streams to the user terminals, each of the audio streams including associated spatialization information;

- a rendering system for rendering the audio streams to predetermined virtual locations around a user; and

- a user interface for virtually spatially locating a user amongst the audio streams;

wherein the rendering system spatializes the audio streams so as to maintain a substantially spatially coherent audio reference frame around the user, the user interface includes a visual indicator of the spatial position of each of the audio streams around a listener and the rendering system substantially maintains a spatially coherent audio reference frame relative to the visual indicator.

Each stream preferably includes user ownership information and the system preferably includes audio stream access interface for granting access to the audio streams.

The rendering system can attenuate audio sources located virtually remotely from a current user and merge audio sources located virtually remotely from a current user. In one embodiment the rendering system can be located adjacent a user and the audio sources are preferably streamed over a computer network.

According to a still further aspect of the invention, a method of providing an interactive spatialized audio facility comprises the steps of:

- receiving from a plurality of user-based audio sources a plurality of corresponding audio streams and associated locating data capable of virtually locating the audio sources relative to one another within a virtual environment;

- reading user status data;

- selecting at least some of the audio sources based on the user status data;

- transmitting the selected audio streams and associated locating data to a first listener destination for enabling the display of visual representations of the virtual locations of at least some of the selected audio sources within the virtual environment;

- spatializing the selected audio streams relative to a first listener-based audio reference frame which is substantially coherent with the visual representations of the audio sources;

- selecting at least some of the audio streams in a second selection process; and

- transmitting the selected audio streams and associated locating information to a second listener destination for enabling the display of visual representations of the locations of at least the selected audio sources, and spatializing at the second listener destination the selected audio streams in an audio reference frame which is substantially coherent with the visual representations of the audio sources.

In one form of the invention, multiple selection processes are used to select the audio streams according to the predetermined algorithm, the selected audio streams and associated locating information are transmitted to multiple listener destinations, and visible representations of the locations of at least the selected audio sources are displayed at the multiple listener

destinations, with each of the selected audio streams being spatialized at the multiple listener destinations in audio reference frames which are substantially coherent with the visible representations of the audio sources.

Brief description of the drawings

Notwithstanding any other forms which may fall within the scope of the present invention, preferred forms of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 illustrates schematically a first embodiment of a user interface for an audio chat room of the preferred embodiment;

Figure 2 illustrates a streaming environment of the first embodiment;

Figure 3 illustrates a schematic flowchart showing the operation of a rendering computer of the first embodiment;

Figure 4 illustrates a highly schematic functional block diagram of a second embodiment of a spatialized audio conversation system of the invention;

Figure 5 shows a more detailed functional block diagram of an audio component of a streaming server;

Figure 6 shows a more detailed functional block diagram of a user terminal adapted to be connected to the streaming server of Figure 5;

Figure 7 shows a more detailed block diagram of a second embodiment of an audio component of a streaming server;

Figure 8 shows a functional block diagram of a second embodiment of a user terminal adapted to be connected to the streaming server of Figure 7;

Figure 9 shows a functional block diagram of an audio component of a third embodiment of a streaming server of the invention; and

Figure 10 illustrates a schematic view of a user interface screen which corresponds to the server configuration illustrated in Figure 9.

Detailed description of the embodiments

In the preferred embodiment, there is provided a chat room facility which includes audio spatialization and rendering technologies to provide for a spatialized form of audio chat room. The preferred embodiment can be implemented via suitable C++ programming of standard high end personal computer equipment.

Turning now to Figure 1, there is illustrated an example of a user using the interface screen for utilization with a first embodiment of the invention.

A user 1 enters a virtual chat room which comprises a two dimensional array 2 on the user's screen. The chat room in this particular case is one dealing with the "LINUX" operating system. The chat room consists of a number of groups 5, 6, 7 and 8 of users 9 discussing various topics. The user interface includes a mouse pointer 4 which can be utilised in conjunction with a mouse to grab the user 1 and move the user towards different groups such as group 5 and further orient the user relative to the group. The user 1 is equipped with a set of headphones and, as the user approaches the group 5, the conversation of that group initially appears in the distance and the conversation comes closer to the individual. Further, the conversation can be spatialized such that the conversations of the group 5 appear on the left hand side of the user 1 and the conversations of the group 6 appear on the right hand side of the user. The user is equipped with a microphone and, as a result, can thereby contribute to the conversation. Further, alternative audio inputs such as music tracks can be provided for the other listeners in the environment.

Each listener in the virtual environment is provided with a similar screen with a clearly identified current position locater. Listeners move around in the space defined by the "wall" 10 of the chat room listening to various conversations and contributing to the conversations. Each member of the chat room is able to take part in localised spatialized conversations with other members.

Turning now to Figure 2, there is illustrated schematically one form of structural embodiment of an implementation of the arrangement of Figure 1. The system can be based around a personal computer 11 having sound card processing capabilities so as to provide for output audio over headphones 12 in addition to a microphone input 13. The rendering computer

11 is interconnected with a streaming server 14 which streams the audio channels of each participant over a network which is in this case an Internet type streaming system 15. A series of other users 16 are similarly interconnected to the streaming server 14 which streams audio dialogue in addition to dialogue position information. The audio dialogue of the user 17 is also forwarded back to the server 14 for streaming to each participant.

The rendering computer can therefore operate as illustrated in Figure 3. From the network stream 20 there is provided a series of chat room occupant streams 21. Each chat room occupant stream contains a voice channel and the position and orientation of the user of the voice channel. Similarly, output 22 from the rendering computer is the local user's voice channel and associated position information. The position and orientation information is utilised to update a display 23 so as to update the current position and orientation of each individual. The position information is also forwarded to relative positioning determination unit 24 for determining a current position of each listener relative to the current listener.

The relative position determination output is forwarded to an optional voice channel culling unit 26. Voices that are attenuated with distance may be culled in accordance with the preset preferences. Additionally, a group or cluster of distance voices can be combined into a single voice or quasi-voice via superposition of the voice channels. The utilization of culling and combining operates to reduce the number of voice channels that must be subjected to spatialized audio rendering 27.

The spatialized audio rendering takes the voice channel inputs in addition to the relative location information and culling information and utilises techniques for spatialization to place the voices around a listener at predetermined locations.

Suitable techniques for spatialization include those disclosed in PCT publication no. WO99/49574 entitled "Audio Signal Processing Method and Apparatus", filed 6 January 1999 and assigned to the present applicant, the contents of which are specifically incorporated by cross reference. The spatialization techniques disclosed allow a voice to be located relative to a headphone listener. Each of the input audio channels can be separately spatialized or can be first rendered to a standard reference frame such as a Dolby® Surround Sound five channel reference

frame and then rotated to an absolute reference frame before a final rotation to the relative reference frame of the listener. The signals are combined and then output to the listener.

The spatialized conversation system can also be combined with binaural rendering technologies to provide for fully immersive behaviour. For example, United States Standard Application No 08/893848 which claims priority from Australian Provisional Application No. PO0996, both contents of which are specifically incorporated by cross reference, discloses a system for rendering a B-formatted sound source in a head tracked environment at a particular location relative to a listener. Hence, if the audio tracks are stored in a B-format then such a system, suitably adapted, can be used to render the audio tracks. One example of where such a system is suitable is where the B-format part of the rendering to be done centrally, and the headtracking part (which is applied to the B-format signal to generate headphone signal) is done locally. B-field calculation can be expensive and is best done centrally. Central computation incurs communication delays, and this has the effect of introducing latency in position, which is not too detrimental. Headtracking is done locally because this is very sensitive to latency.

Alternatively, PCT publication no. WO99/51063 discloses a system for Headtracked Processing for headtracked playback of audio in particular in the presence of head movements. Such a system could be used as the rendering engine by rendering the audio track to a predetermined format (e.g. Dolby 5.1 channel surround) so as to have a predetermined location relative to a listener, and, in turn, utilising the system described in the PCT application to then provide for the localisation of an audio signal in the presence of head movements.

Various user interface modifications to the preferred embodiment are also possible. For example, an announcer audio channel can also be provided which provides a "god like" voice which announces the entrance and exit of users. A joystick or mouse can be provided so that a user can "walk" around the environment. Other users can have a choice of accepting or declining chat requests.

Hence, in the above embodiment, users conduct their conversation / chat sessions in the conventional way – through speech. The user wears a set of headphones with a transmitter attached which communicates with a receiver connected to a phone line, establishing the Internet online connection. As new users log onto the chat program, or so-called 'chat-rooms',

they receive a voice announcement of the existing users in the room and their details. The display also shows where the user is located with respect to all other existing users in the chat room. The user can 'move' around the room (located on the display) and can walk up to any users in trying to set up an individual conversation. Of course, in one form of the embodiment all users have a choice of accepting or declining chat requests.

Referring now to Figure 4, a streaming server 30 is shown connected via the internet to a number of user terminals 32.1 to 32.N. The streaming server incorporates a user status database 34 which is typically SQL-based. The user status database is constantly updated with user location and status information via inputs 36 from each of the user terminals 32.1 to 32.N. The user location data includes the position and orientation of each user both with respect to the other users and to the chat room(s) within the chat room environment. The status information includes the particular status of the user at a particular time. For example, the user may have various categories of listener status allowing the user to listen to other selected users or groups in the chat room. Similarly, the talk status of the user may be altered from the lowest "mute" status to, say, a highest "voice of god", "soapbox" or "moderator" status in which that particular user may be in a position, respectively to talk at will, to broadcast a message or speech throughout the chat room environment, or, to control the talk and listen statuses of other users within the chat room environment. Multiple outputs 38 from the user status database lead to multiplexer-type select M functions 40.1 to 40.N connected to the respective user terminals 32.1 to 32.N via user location and status inputs 41 and via audio inputs 42 through an audio engine 43.

The operation of the audio component of the streaming server will now be described in more detail with reference to Figure 5. In the server, an audio bus 44 is provided comprising all of the audio channels of the N users. Each of the channels, such as those indicated at 44.1 and 44.2, have corresponding audio or microphone inputs 46.1 and 46.2. Outputs 48.1 to 48.N from each of the lines in the audio bus 44.N are fed into the select M functions 40.1 to 40.N. M output audio channels 50 are fed from the select M functions to each of the user terminals 32.1-32.N of Figure 4. There are numerous different methods or algorithms that can be used to control exactly which audio channels are selected for a particular user. Two of the main control

criteria are the manner in which the user or listener obtains permission to enter a chat room, and exactly who gets heard by whom in each chat room.

Typically, a new entrant to the room will go through an approval process prior to being allowed entry. As a result, private conversations can be held between participants in the particular room, safe in the knowledge that new entrants can not "sneak in" without prior notification to the existing participants. The selection process may be autocratic, via a moderator or chairman, or may be democratic, by way of a users' vote. User entry could also be password controlled in the case of a regular chat group.

Referring back to Figure 1, a new entrant 52 would position himself or herself at the entrance 54 of the virtual chat room 3 appearing on the user interface screen and would request entry into the room, by, say, clicking on a "request entry" icon. One of the processes described above could then take place. As an alternative, a particular group 7 could, by mutual consent, erect a "sound proof" barrier 56 around their conversation. Similar entry criteria would apply if a user was in the room and wanted to join in the discussion.

Once the user 52 has entered the chat room, various other methods can be used to determine exactly who the user or listener will hear. In one version, the M closest sources can be selected from the N sources. Alternatively, the M loudest sources may be selected, where loudness is based on the amplitude of the source signal as well as the distance of the source from the listener.

A moderator, which could be user 1, could also be used to select who is to be heard, on behalf of all listeners in the room. A further variation is that the moderator could select M' sources on behalf of the group, and listener-individualised selection could be used for the remaining M-M' sources.

As far as talking status is concerned, listeners may request permission to speak, by signalling to the moderator 1 their desire. The moderator can then review the "queue" of listeners and select who is to be heard by heard the group. One method of selection could be for each of the prospective talkers to provide a brief textual précis of their proposed contribution. Where there are several groups in the chat room, with several different conversations going on

simultaneously, each of the groups 5, 6, 7 and 8 may have a group moderator or chairperson to control the flow of the discussion within a particular group.

Referring back to Figure 5, all of the audio channels to the audio bus 44 are combined at a summer 58, and the summed signal 60 undergoes a binaural reverberation process, such as the B-format rending process described above with reference to USSN 08/893848. The left and right binaural reverberation outputs 64 and 66 effectively form part of the audio bus 44, with left and right summed binaural reverberation inputs 64.1 to 64.N and 66.1 to 66.N being fed to each of the user terminals 32.1 to 32.N.

Referring now to Figure 6, the user terminal 32.1 is shown having M audio channel inputs 50.1 to 50.M which are separately spatalized by binaural rending using HRTF processes 68.1 to 68.M. The binaurally rendered signals are summed at left and right summers 70 and 72 which are fed to the respective left and right earpieces of a set of headphones 74 worn by the user. The left and right binaural reverberation signals 64.1 and 66.1 are also fed to the respective left and right summers 70 and 72. The summed binaural reverberation signals 64.1 and 66.1 produce background reverberation which allows the user to experience not only, say, the three or four closest voices in the room, but also the background hubbub representative of all of the summed voices in the chat room environment. This makes for an audio experience which is far more realistic without requiring an inordinate number of input audio channels.

In the embodiment of Figures 5 and 6, the bulk of the digital signal processing and channel selecting occurs at the streaming server, to the extent that the audio signal processing functions illustrated in Figure 6 can be incorporated into the right and left earpieces of the headphone 74, which is in turn connected to the rendering computer. The rendering computer in turn incorporates the visual user interface, providing user location and status information to update the user status database 34. It also receives the updated user location and status information from the demultiplexer function 40.1 to 40.N so that the user interface screen can be constantly updated with the whereabouts and statuses of the other users in the chat room.

Referring now to Figure 7, a second embodiment of an audio component of a streaming server 76 is shown which is similar to the first embodiment, save that the binaural reverberation function has been removed. Instead, the summed output signal 60 from the summer 58 is fed as

an unprocessed summed input signal 60.1 to 60.M to each of the user terminals, one of which is shown at 78.1 in Figure 8. The binaural reverberation function 80 of the summed signal 60.1 takes place at the user end either within the rendering computer or within the headphones 74, together with the HRTF functions 68.1 to 68.M. In this way, the number of input channels is reduced, at the expense of additional processing power at the user end.

In Figures 9 and 10, a more sophisticated version of a spatalized conversation system is illustrated. The audio component of the streaming server 32 comprises an audio bus 84 having source signal channels from eight users numbered from 91 to 98. In Figure 10, a user interface screen is shown comprising chat rooms A and B divided by a wall 100 having an interleading doorway 102. Users 91, 92, 94 and 96 are located in room A, and users 93, 95, 97 and 98 are located in room B. The audio channels to and from the users 92, 93 and 95 are shown. Each of the users feeds his or her microphone signal into the server as a mono signal, as is shown at 104. Each of the users 92, 93 and 95 is fed with the three closest or chosen sources, including signals from other users or from the doorway 102. The summed room hubbub for room A is summed at 106, and includes audio channels from the users 91, 92, 94 and 96, together with a so-called "wet room" signal 108 from room B. This signal is made up of the signals from the users 93, 95, 97 and 98 which are summed at 110, together with the "wet room" signal 112 from room A. The directly summed output signal 116 from the summer 110 constitutes a "dry room" signal for room B. The "dry room" signal for room B is fed through a mono-reverberator 118 to provide a "wet room" signal output 120 for room B. This is in turn fed into the summer 106 for room A. The directly summed output 122 from the summer 106 is a "dry room" signal in respect of room A, with the "dry room" signal being processed by a mono-reverberator 124 to become a wet room signal 126 for room A.

The user 95 thus has as inputs the closest three users 93, 97 and 98 in room B, as well as the summed room hubbub constituted by the dry room signal 116 for room B. The user 93, on the other hand, has as inputs the closest two users 97 and 95, together with a doorway signal 128 constituted by the "wet room" reverberated output 126 from room A. In addition, user 93 in room B receives as an input a dry room input 130 representative of the background noise or hubbub in room B.

The user 92 in room A receives as inputs voice channels from the closest two users 91 and 96, together with a doorway signal constituted by a "wet room" signal 132 from the "wet room" output 120 of room B, together with a "dry room" output signal 134 from room A representative of the background noise in that room.

An audio experience which is consistent with a dual chat room environment is achieved, in that users in one room which are close to the doorway receive "wet room" input from the other room as a dedicated input channel. For users further away from the doorway and the other room, a reduced input from the other room is still achieved by virtue of the feedback of "wet room" signals 108 and 112 which are combined at the respective summers 106 and 110. This feature gives the user the ability to hear distant hubbub transmitted through multiple rooms and doors, and to navigate by sound to find the room with the greatest level of audible activity.

The gain of the fed back door signals 108 and 112 may be modified at 138 depending on whether the door is partly or fully open or closed, thereby enhancing the realism of the chat room environment and selectively allowing or preventing eavesdropping, in particular where it is possible for one or more of the users to "close" or "open" doors.

It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or drawings. All of these different combinations constitute various alternative aspects of the invention.

The foregoing describes embodiments of the present invention and modifications, obvious to those skilled in the art can be made thereto, without departing from the scope of the present invention.

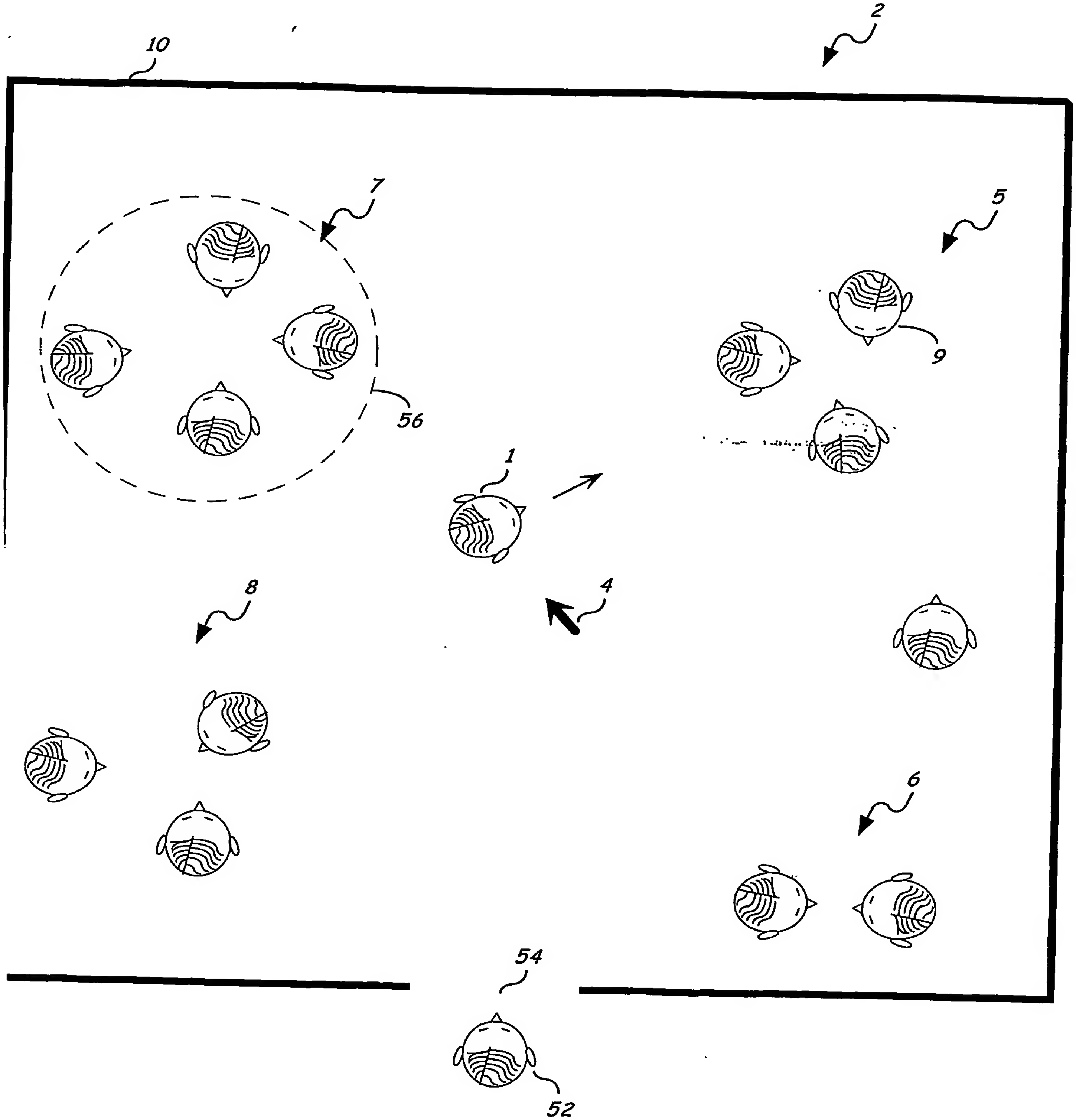

Fig 1

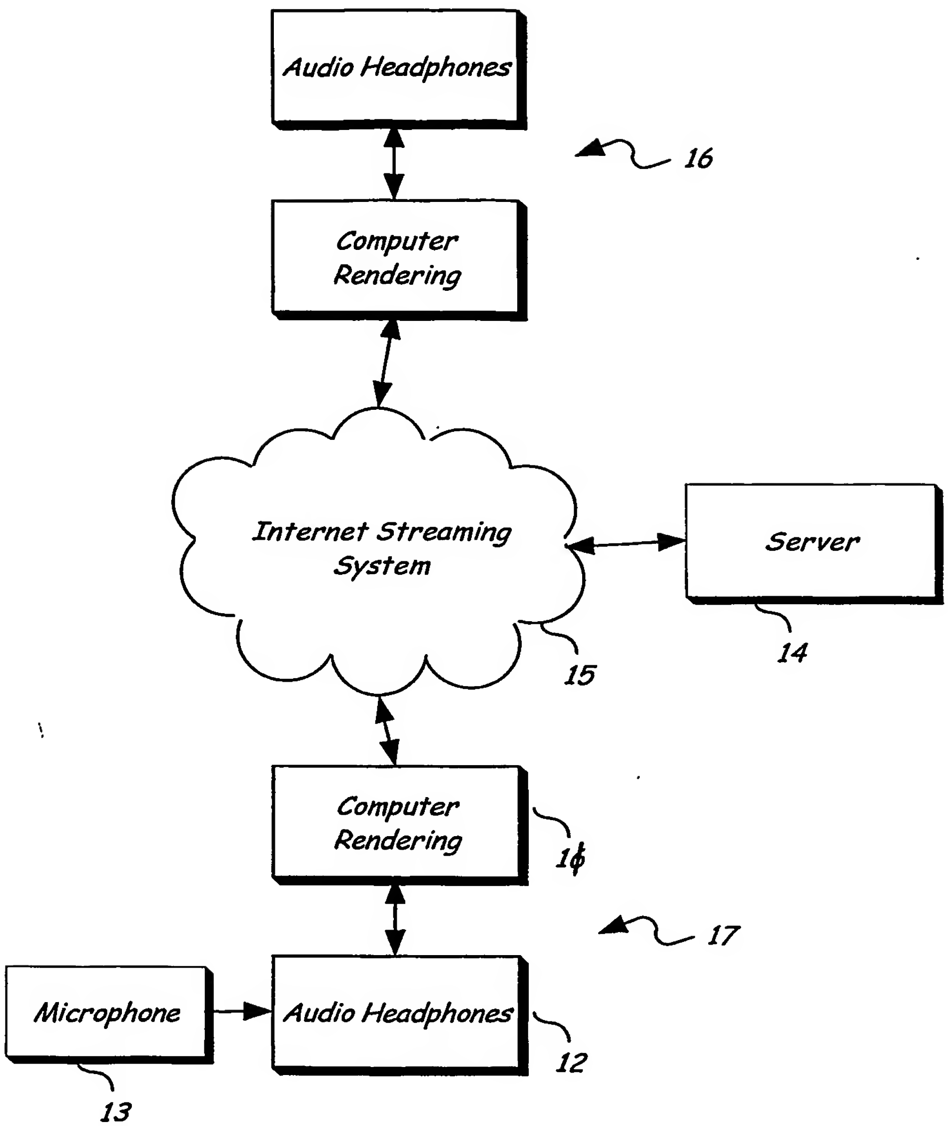
Audio Headphones
16
Computer Rendering
Internet Streaming System
Server
15
14
Computer Rendering
10
17
Microphone
Audio Headphones
12
13

Fig 2

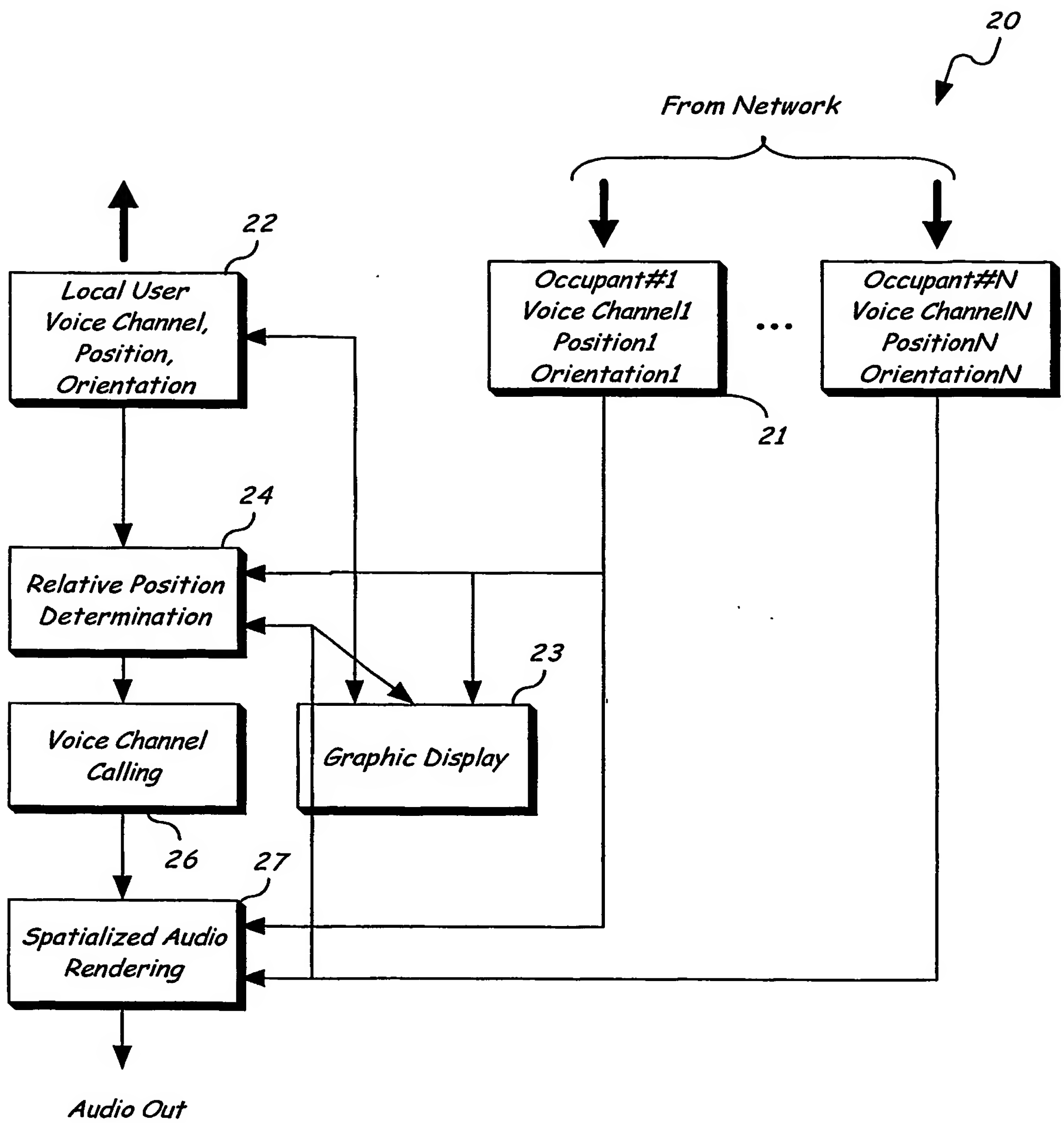
20
From Network
22
Local User Voice Channel, Position, Orientation
Occupant#1 Voice Channel1 Position1 Orientation1
...
Occupant#N Voice ChannelN PositionN OrientationN
21
24
Relative Position Determination
23
Voice Channel Calling
Graphic Display
26
27
Spatialized Audio Rendering
Audio Out

Fig 3

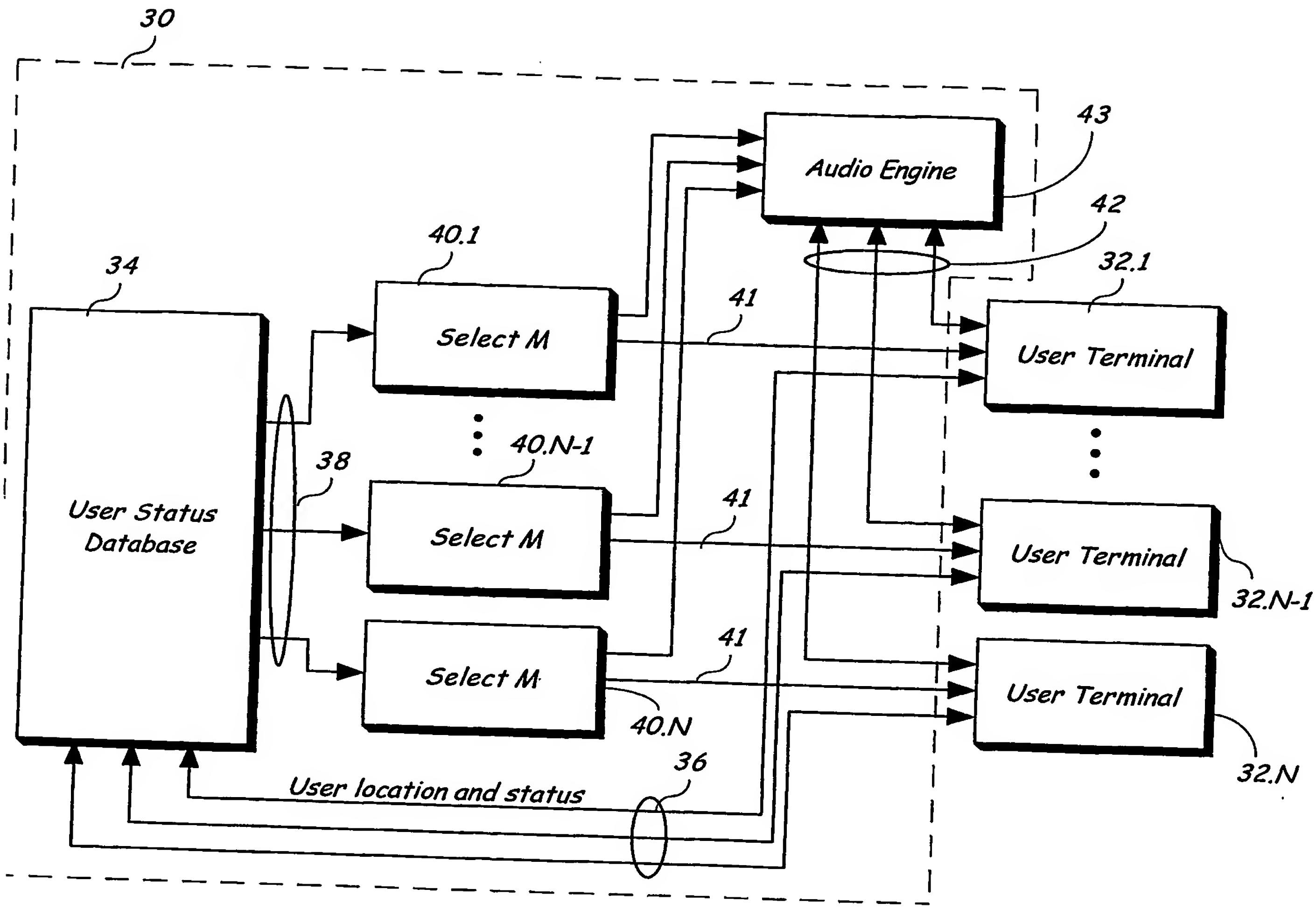
30
43
Audio Engine
42
40.1
34
32.1
Select M
41
User Terminal
User Status
Database
38
40.N-1
Select M
41
User Terminal
32.N-1
Select M
41
User Terminal
40.N
32.N
36
User location and status

Fig 4

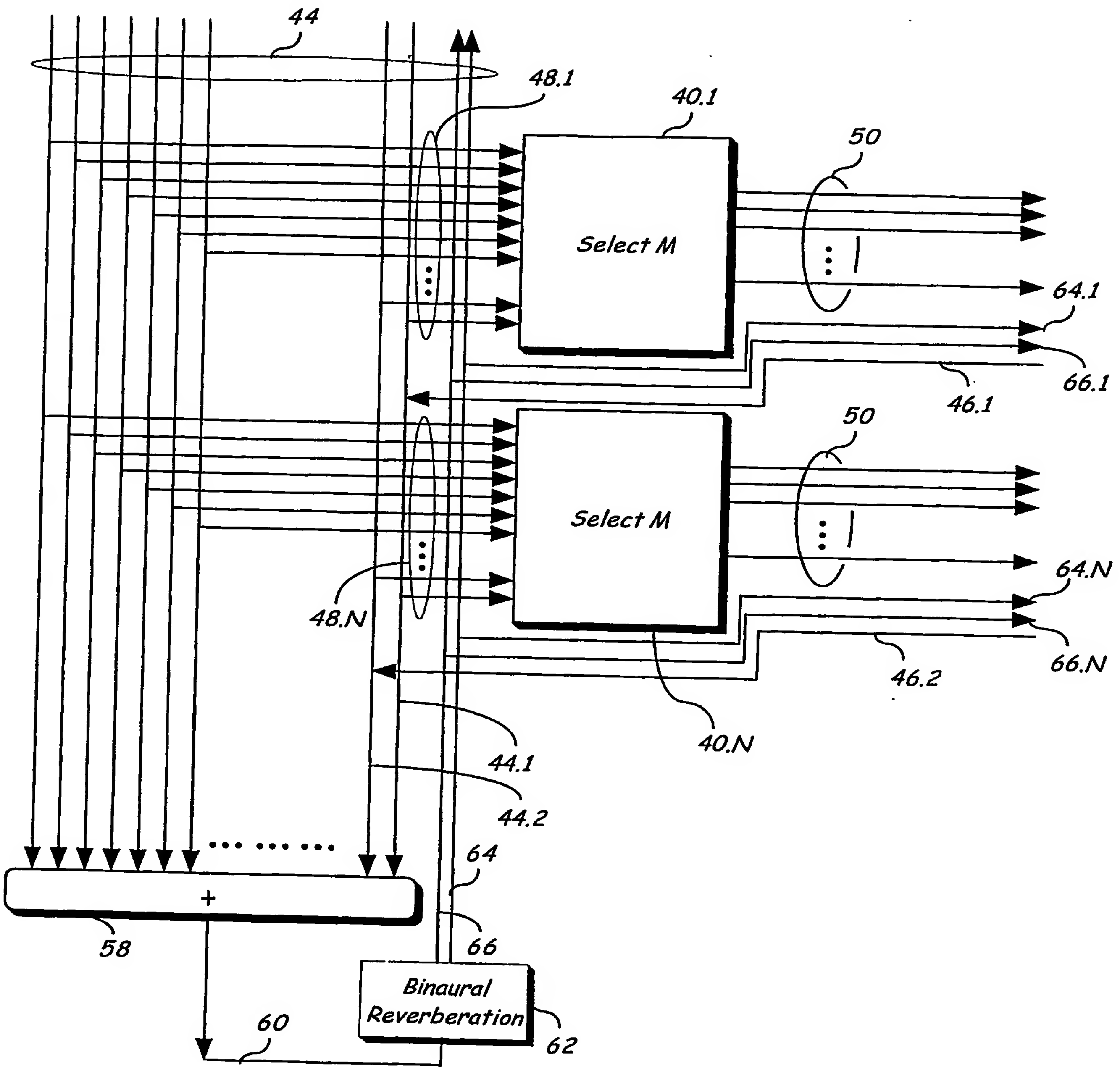
44
48.1
40.1
50
Select M
64.1
66.1
46.1
50
Select M
64.N
48.N
66.N
46.2
40.N
44.1
44.2
64
+
58
66
Binaural
Reverberation
60
62

Fig 5

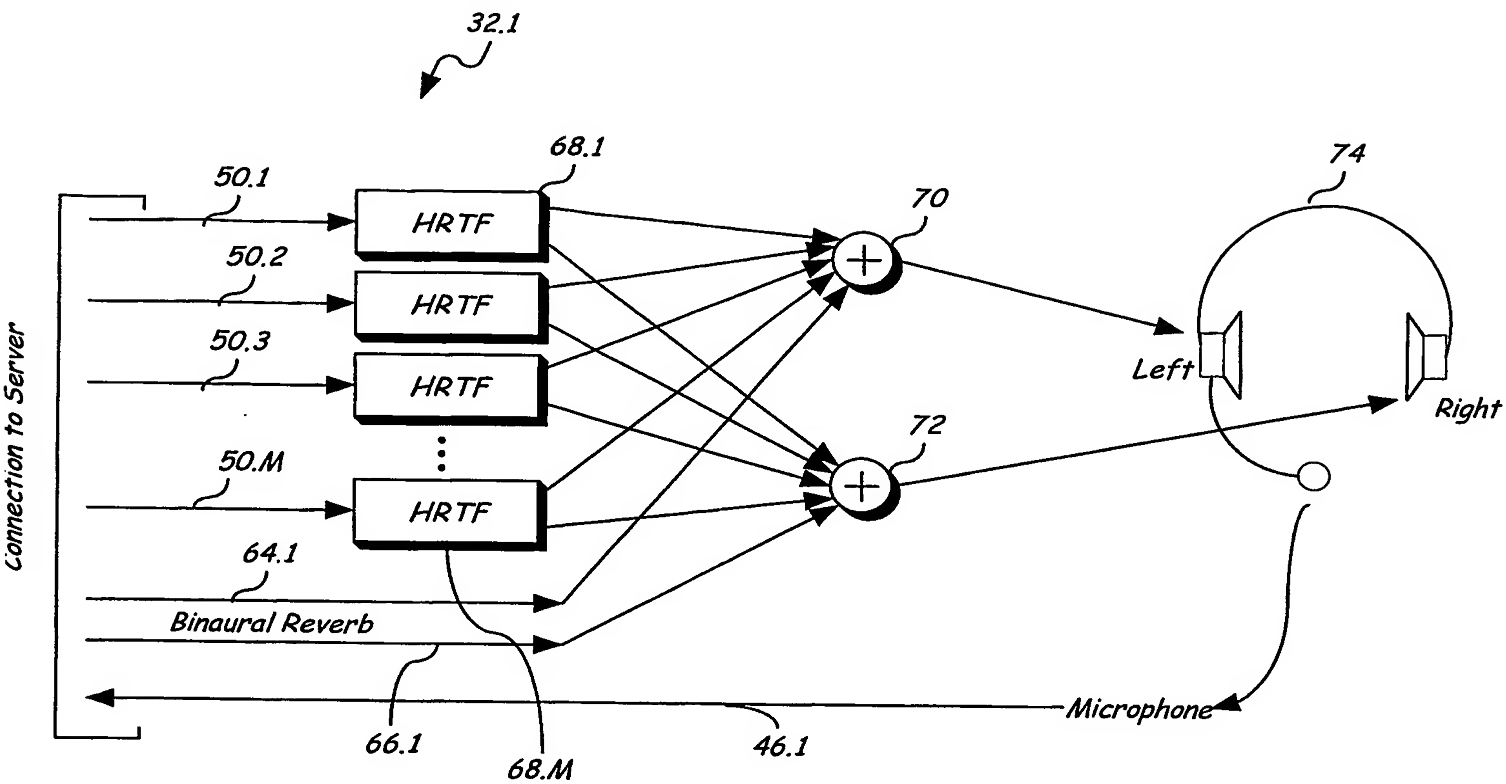
32.1
68.1
74
50.1
HRTF
70
50.2
HRTF
50.3
HRTF
Left
Right
Connection to Server
72
50.M
HRTF
64.1
Binaural Reverb
Microphone
66.1
46.1
68.M

Fig 6

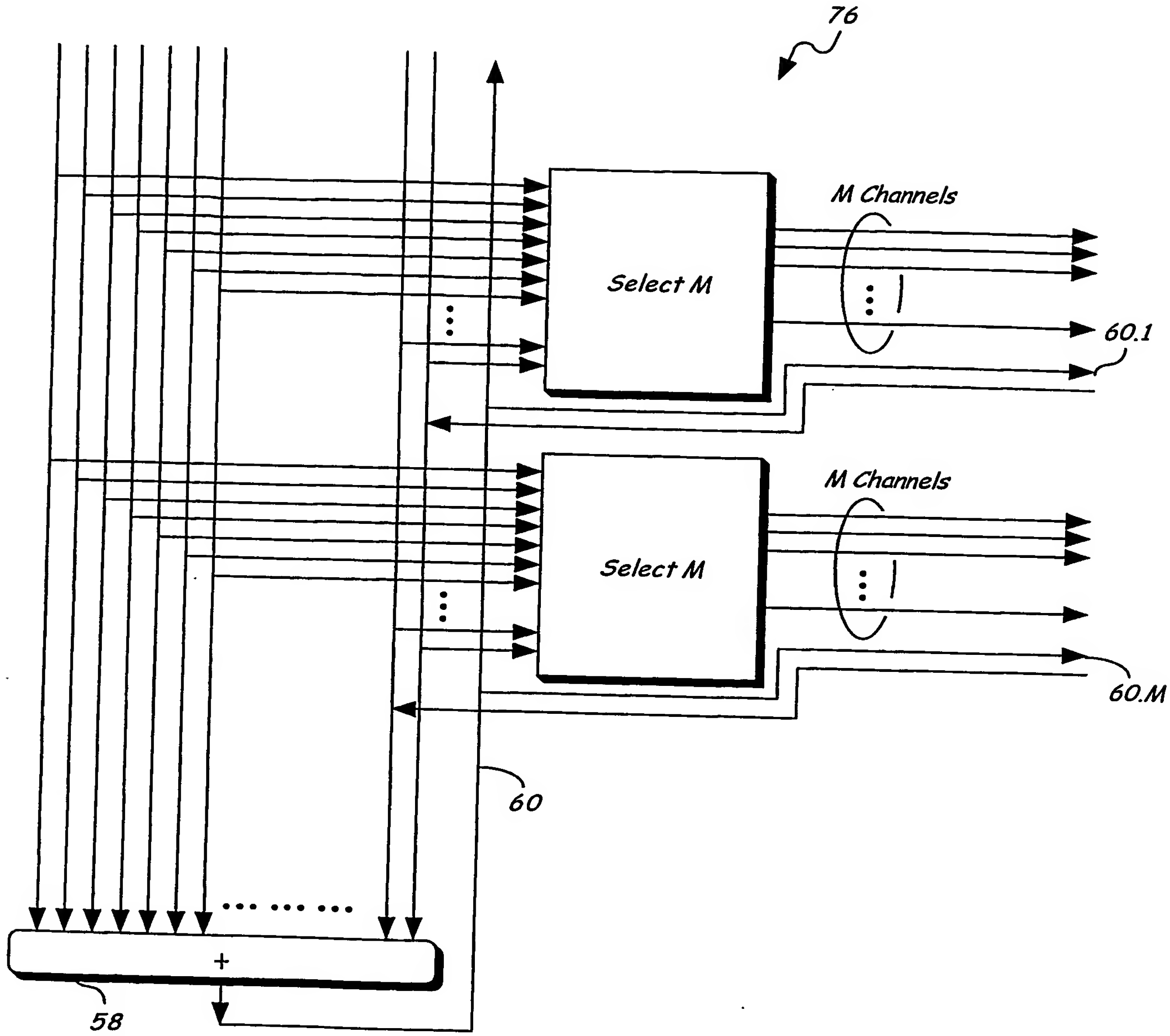

Fig 7

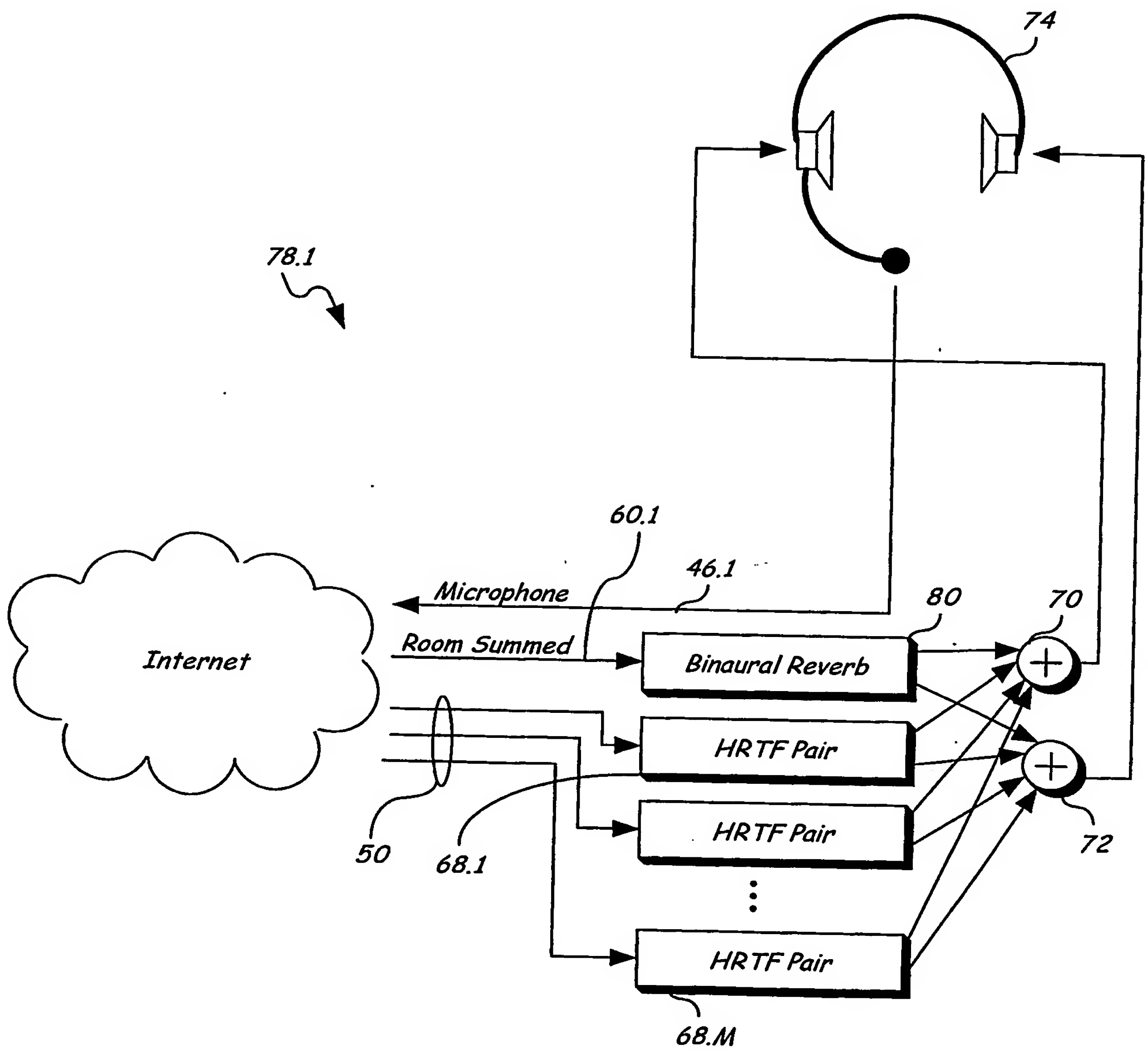
74
78.1
60.1
46.1
Microphone
80
70
Room Summed
Internet
Binaural Reverb
HRTF Pair
HRTF Pair
HRTF Pair
50
68.1
72
68.M

Fig 8

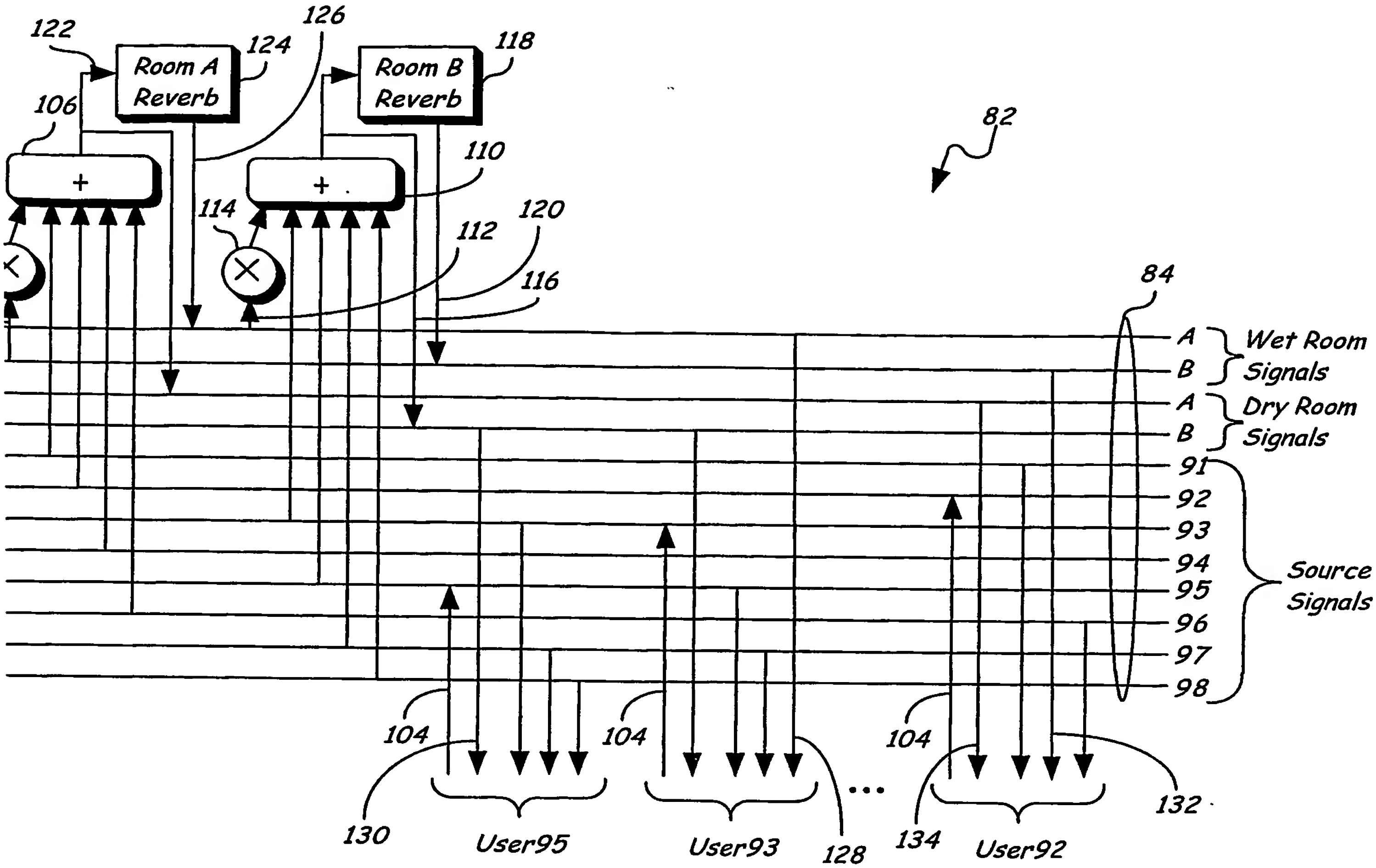
122
Room A Reverb
124
126
Room B Reverb
118
106
82
110
114
120
112
116
84
A
B
Wet Room Signals
A
B
Dry Room Signals
91
92
93
94
95
96
97
98
Source Signals
104
104
104
130
User95
User93
128
134
User92
132

Fig 9

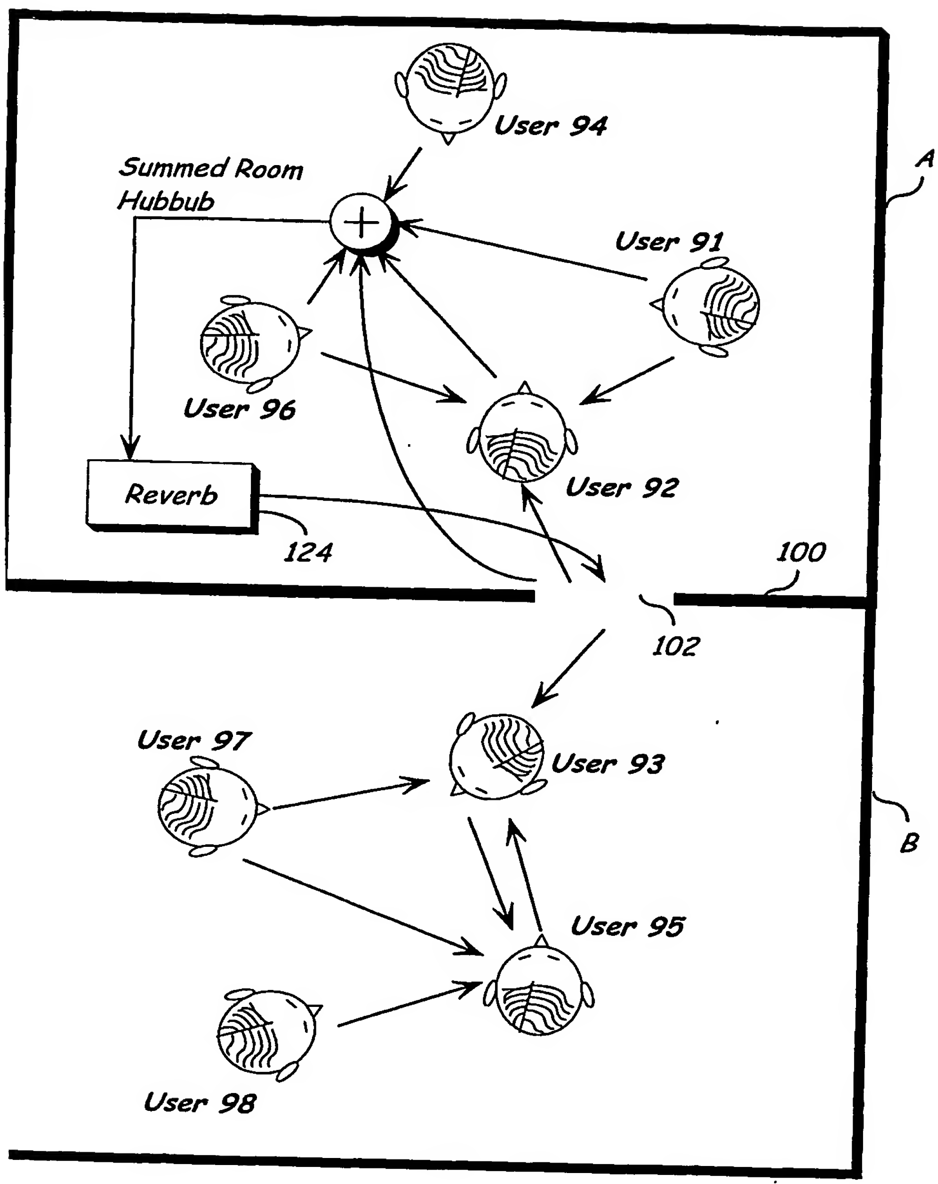
User 94
Summed Room
Hubbub
A
User 91
User 96
User 92
Reverb
124
100
102
User 97
User 93
B
User 95
User 98

Fig 10